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ABSTRACT

The syndrome of childhood autism is typified by major abnormalities in language development, yet there are few systematic descriptions of autistic children's linguistic systems. This paper represents the beginning of a comprehensive investigation of the language of verbal autistic children and concentrates on comparing the syntax used by ten verbal autistic children matched for nonlinguistic mental age with a group of mentally retarded subjects and normal controls. Two different means of assessing syntactic development were utilized: Lee's developmental sentence analysis and Chomsky's transformational analysis. The autistic group was found to rank significantly lower than either the mentally retarded or the normal group in terms of Developmental Sentence Scores. When a transformational grammar was used to describe the language samples of our subjects, the autistic children were typified by a higher error rate and lower level of complexity compared to the other two groups. However, the results also indicate that the grammatical system of autistic children is rule-governed and probably not unlike that of young normal or retarded children. In conclusion, it appears that the syntactic abnormalities characteristic of autism are attributable to an extreme delay in language development as well as to an impaired ability to make use of linguistic rules. (Author/AM)

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A Syntactic Investigation of Verbal Autistic, Mentally Retarded, and Normal Children

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Informed consent was obtained from the parents of the subjects following explanation of the procedures used in our work.

G. BARTOLUCCI, M.D.

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Subjects were provided by the Ontario Society for Autistic Children, the Thistletown Regional Centre in Rexdale, Ontario, the Hamilton Board of Education, and the Hamilton-Wentworth Separate School Board.

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Abstract

The syndrome of childhood autism is typified by major abnormalities in language development, yet there are few systematic descriptions of autistic children's linguistic systems. We have, therefore, begun a comprehensive investigation of the language of verbal autistic children and concentrate in this paper on comparing the syntax used by ten verbal autistic children matched for nonlinguistic mental age with a group of mentally retarded subjects and normal controls. Two different means of assessing syntactic development were utilized: Lee's Developmental Sentence analysis and Chomsky's Transformational analysis. The autistic group was found to rank significantly lower than either the mentally retarded or the normal group in terms of Developmental Sentence Scores. When a transformational grammar was used to describe the language samples of our subjects, the autistic children were typified by a higher error rate and lower level of complexity compared to the other two groups. However, the results also indicate that the grammatical system of autistic children is rule-governed and probably not unlike that of young normal or retarded children. In conclusion, it appears that the syntactic abnormalities characteristic of autism are attributable to an extreme delay in language development as well as to an impaired ability to make use of linguistic rules.

Researchers agree that language dysfunction is one of the prime symptoms of the syndrome of childhood autism (Kanner, 1943; Rimland, 1964; Rutter, 1968). It has also been suggested by several investigators that there is a possible correlation between the level of language which an autistic child achieves by age five and favorable outcome for that child (Eisenberg, 1956; Wing, 1971). Yet, despite the central role that language plays in autism, it remains one of the least systematically investigated aspects of the syndrome (Baker, Cantwell, Rutter, & Bartak, 1976).

References in the literature to the language of autistic children are for the most part impressionistic and consist of descriptions of delayed acquisition and atypical features, such as echolalia, neologisms, fragmented and abbreviated speech forms, difficulties with abstract language and in generalizing word meanings to situations other than those in which they were learned, and failure to use the pronoun "I" and the affirmative "yes" (Wing, 1975). Other studies describe frequent confusion among words of similar connotation, the use of fragments of speech and "portmanteau" expressions to convey meaning, and a marked tendency to contract phrases and even words to the barest minimum, as well as slowness in learning the "small words" of language such as prepositions, conjunctions, and pronouns, and the dropping of these words even when learned (Ricks & Wing, 1976).

Many of these features are not unlike the language abnormalities typifying developmental receptive aphasia, but comparative investigations have shown them to be even more prevalent in autism (Bartak, Rutter, & Cox, 1975).

Another series of studies (Shapiro & Fish, 1969; Shapiro, Ginsberg & Fish, 1972; Shapiro, 1974; Shapiro, Chiardini & Fish, 1974; Shapiro, 1975) uses syntax as a formal measure of "communicativeness", which had earlier been estimated only by clinical gestalt. The method employed does not, however, study syntax per se, but rather surveys the range of communicative functions such as expression, appeal, proposition, echoing, and reference that are found in patients' speech. Such studies are able to define a spectrum of deviant language patterns and their course, and permit the differentiation of the language of childhood schizophrenics (including autism) from children with developmental speech lags and from mentally retarded children.

Similarly, another set of studies (Frank & Osser, 1970; Frank, Allen, Stein & Myers, 1976) uses syntactic indices, including a subset of grammatical transformations, to assess quantitative and qualitative aspects of communicative deviance in mother-child interactions. The mother-child dyads consisted of schizophrenic mothers, mothers of autistic children, and mothers of normal children and studied how they communicate with their four year old children.

None of these studies actually provides a systematic study of syntax. Each utilizes elements of syntax to quantify semantic and pragmatic aspects of the children's language. Language is a system of systems which is equal to more than the sum of its parts.

Consequently, a truly systematic study of language entails a thorough investigation of the comprehension and production of linguistic elements at the 'phonological' or speech sound level[1], the 'syntactic' or level of grammatical organization, and the 'semantic' or meaning level of language[2] and how they are fit together as a functional whole. A study of just one level alone will not provide all of the information needed for a true characterization of language, but neither will the mixing of information from different levels, without complete knowledge of the levels themselves. One can hope that ultimately such a thorough investigation of language will permit not only the differentiation of clinical syndromes such as autism, but also will allow for some insight into the nature of the syndrome itself.

As many of the reports in the literature single out syntactic difficulties in autistic children, this study uses syntax as the starting point for looking into the language system of autistic children.

Syntax can be studied in two ways: either tests can be administered to tap specific areas of comprehension and production in children, or samples of relatively spontaneous speech can be collected, from which it is possible to deduce the set of grammatical rules which explain the linguistic system of the speaker. In light of recent reports showing that performance on language tests is not an accurate reflection of performance in free speech (Dever, 1972; Prutting, 1975), the latter method was chosen for this study.

Subjects

Three groups of subjects were used in this study: verbal autistic, mentally retarded, and normal children. All potential subjects were given the Arthur Adaptation of the Leiter International Performance Scale (1952) to establish their nonlinguistic mental ages (NLMA). The retarded and normal subjects were selected so that their NLMA's would be comparable to those of the autistic group. Each of the final groups consisted of ten children and had a mean NLMA of approximately six years. Group characteristics are summarized in Table 1.

Insert Table 1 about here

A one-way analysis of variance (Bruning & Kintz, 1968) indicates that the normal, autistic, and retarded groups do not differ significantly in nonlinguistic mental age. ($F = .31$, $df = 2,27$) The matching according to this variable is therefore adequate. However, as might be expected, there is a significant difference in IQ level between the groups (one-way analysis of variance yields $F = 25.38$, $df = 2, 27$, $p < .001$) A Scheffé test (Ferguson, 1971) indicates that the IQ level of the normal group is significantly higher than that of either of the other two groups ($p < .05$), and that the retarded and autistic samples are homogeneous with respect to IQ level. Consequently, the autistic group in this study is being compared with a group of younger but intellectually normal children who have the same level of mental

functioning as measured by the Leiter, as well as with a group of delayed developers who have attained the same level of functioning as the normal group over a longer period of time.

Certain qualificatory criteria were applied in considering the eligibility of children for this study. All children were Canadian-born, Caucasian, and had English as their native language. Also, all children were free of hearing loss and any possible neurological signs or known brain damage according to medical and school records. The entire sample live in or within a sixty mile radius of Hamilton, Ontario.

The autistic children were identified according to the presence or a definite history of all four of the following behavioral characteristics:

1. A lack of responsiveness or active avoidance of the human figure, including avoidance of eye contact, body contact, and the tendency to relate to the human figure in parts rather than as a total gestalt;
2. A preoccupation with sameness in the environment as manifested by compulsive orderliness, ritualistic behavior, and panic attacks or temper tantrums following changes in the environment or in routine activities;
3. Language deviance characterized either by abnormally slow development from the outset or by loss of previous speech habits very early in life, complemented by obvious echolalia and the observed tendency to reverse the pronouns "I" and "you";

4. Age of onset prior to thirty months of age.

Both investigators had to agree on the assessment for inclusion of a child in the study.

These criteria for identification are in keeping with those outlined in Kanner's original paper (1943) and used by other researchers in the field such as Rutter (1971) and Hermelin and O'Connor (1976). They also place our group of subjects in the group of infantile psychoses described by Kolvin (1971).

The mentally retarded group of children were chosen according to a history of delayed development and school records indicating that they fell within the mildly mentally retarded range of IQ 52-67. None of the mentally retarded children showed any of the autistic features as agreed upon by both investigators.

The normal children were selected according to official records indicating that they had average IQ's as determined by independent school assessments and no behavior or speech problems.

Methodology

Data Collection

To collect the data for the syntactic analysis, each child was seen individually in an empty classroom at his school or in his home in a reasonably quiet setting. In general, the autistic children were seen at home and the retarded and normal children at their schools, due to factors beyond the control of the investigators.

The same set of toys and books were presented to all children to permit some uniformity in the stimulus situations. However, no

effort was made to confine the child's conversation to the items present, if he preferred to talk about other things. None of the interviews lasted longer than sixty minutes. Recordings of the interviews were made with a condenser microphone on a Sony TC-106A taperecorder.

Based on literature dealing with the analysis of free speech samples, it was decided that a representative sample of language would be operationally defined as fifty sentences (Lee, 1974).

The interviews were transcribed by listening to the original tapes as many times as necessary to resolve all ambiguities. The corpus was divided into sentences, using a subject's intonation and pause patterns to indicate sentence boundaries as well as the methodology for delimiting sentences described by Lee (1974). Simple one-word responses and sentence fragments which did not contain at least one subject and verb were not included in the final 50-sentence corpus. Echolalic utterances were omitted as well. In addition, sentences which had occurred once in the corpus were not counted a second time, if they appeared again in the exact same form.

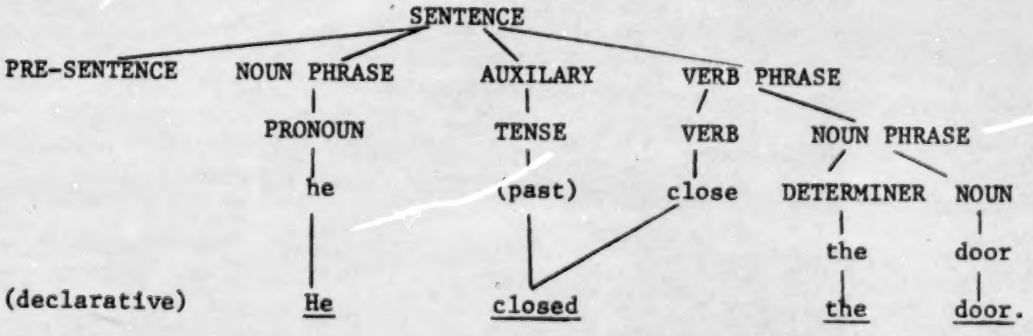
At least two people reviewed all the tapes and reached agreement on any doubtful passages of speech. In the infrequent instances where no agreement could be reached, the particular passage in question was eliminated from the corpus.

A total of 1,429 sentences were obtained from the thirty subjects.

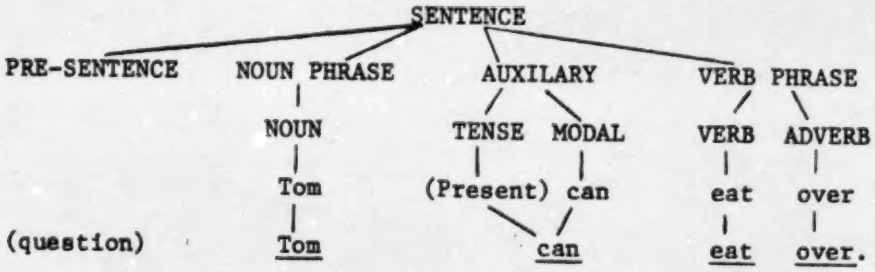
Data Analysis

First of all, each child's overall level of syntactic development was assessed by means of a standardized tool called Developmental Sentence Scoring (Lee, 1974). Each corpus of fifty sentences was scored according to a system which assigns points to eight different categories of grammatical forms such as pronouns, negatives, conjunctions, and interrogative reversals, which are considered to show "the most significant developmental progression in children's language" (Lee, 1974: 136). Each category is subdivided in terms of developmental progression. A grammatical form used by a child receives a score ranging from 1 to 8, depending on its degree of difficulty. The total number of points for the whole corpus is divided by the number of sentences in the corpus, thereby yielding a Developmental Sentence Score (DSS).

For the second part of the analysis, the base grammar and set of transformations needed to generate the fifty surface structure productions of each subject were determined (Chomsky, 1957; Chomsky, 1965; Halle & Ross, 1968). Each utterance was rewritten in the form of a tree diagram illustrating its basic grammatical relations (Chomsky, 1957; Chomsky, 1965). For instance, the sentence "He closed the door" was rewritten in the following way:



In some sentences, because a one-to-one correspondence between the underlying base string or output of the tree structure, and the surface of the sentence does not exist, it is necessary to specify the set of transformational rules needed to recover the original surface structure. For example, the base string of the sentence "Can Tom eat over?" takes the form:



A set of transformations for forming questions is triggered by the Pre-Sentence marker "question" and is responsible for the inversion of the modal "can" and the subject noun "Tom" to give the surface form "Can Tom eat over?".

Transformations are of two basic kinds (Menyuk, 1969): 1. Elementary, which change the base string through operations such as addition, deletion, substitution, or by rearrangement, as in the example of question formation, and 2. Generalized, which act on two or more individual strings to form one derived surface form through operations such as conjoining and embedding, so that, for example, the sentences "The man lives here" and "The man bought a new car" can be expressed in the single surface form, "The man who lives here bought a new car". This sentence can be described by the set of transformations used to embed the sentence "The man lives here" within the sentence "The man bought a new car".

It is important not to overinterpret the findings, but evidence does exist that young normal children use simpler base structures than do older children and that younger children use elaborations of basic syntactic structures less frequently than do older children (Menyuk, 1969). Consequently, maturation of grammatical competence can be characterized at least in part as an increasing ability to discover, use, and expand the rules of grammar with increasing accuracy and economy.

In addition to the structural analysis of the sentences, all grammatical errors made by the subjects were noted. Most errors took the form of deletions. Native speaker intuition must be used to separate inadmissable deletions from lawful ones, because in English conversation, ellipses are common occurrences. For example, a perfectly acceptable answer to the question, "What are you doing?" is "Eating". However, the omission of the determiner in the sentence "He's climbing up trees to tree house" is not considered an acceptable omission. All unlawful deletions and other grammatical errors were counted. An error rate was computed for each subject by calculating the percentage of the total number of sentences in each corpus which contained one or more errors.

Results

When the DSS scores were compared, it became apparent that the level of syntactic ability achieved by the clinical groups was lower than that of the normal six year olds (cf. Table 1). The mean DSS score for the six year olds is 10.3. This score is in keeping with Lee's (1974) norms for six year olds. However, the

mean DSS score for the retarded group is 8.6. According to Lee's norms, the retardates have only reached a level of syntactic development comparable to that of normal four and a half year olds. Moreover, the autistic group falls even further behind the retarded group. Their mean DSS score is 6.7, which, according to Lee's data, reflects the level of syntactic ability achieved by normal three and a half year olds.

An analysis of variance using the DSS scores of all three groups indicates that there is a significant difference between the group scores ($F = 5.6$, $df = 2, 27$, $p < .01$). A Scheffé test indicates that the DSS of the autistic group is significantly lower than that of the normal group ($p < 05$). This shows that even though all three groups are performing on the same level with respect to the nonlinguistic measure of mental age, when a measure of linguistic performance is introduced, the clinical groups fall behind the normal controls. Moreover, the slow-down in syntactic development in the autistic children is even greater than that found in the retardates.

When the sets of base rules needed to characterize the grammars of the subjects in all three groups were compared, we found that children with NLMA below the mean for their groups tended to have simpler base grammars, irrespective of the group to which they belonged. This is due to the fact that relative clauses, verb phrase complements, and several verbal aspects involving modals, and the perfect and passive voices are missing from the grammars of

those children. As the variability in NLMA scores is considerably greater in the autistic and the retarded group than in the normal group, it is not surprising that it was only in these two groups that simpler base grammars were found. It is probable that if younger children of normal intelligence were studied, they too would be using the same sorts of simplified base grammars found in the less advanced mentally retarded and autistic subjects in our study.

A similar picture emerges when the transformation types used by each subject were compared. The number of transformation types found in the grammars of children with NLMA below the mean for their group tended to be lower than those with NLMA above the mean, regardless of the group to which the children belonged.

Insert Figure 1 about here

It was in the comparison of the frequency of occurrence of transformations that differences between the groups appeared. The percentages of sentences generated by using only base string rules, by using elementary transformations, and by using generalized transformations were calculated for each subject. A two factor mixed design analysis of variance showed that two differences existed. (Within subject trials - $F = 6.52$, $df = 2, 54$, $p < .005$; Within subject trials x conditions - $F = 2.76$, $df = 4, 54$, $p < .05$) A Scheffé test was conducted to determine

the nature of the difference. In both cases, it was the autistic group which differed from the other two. For one thing, they produced significantly fewer generalized transformations as compared to elementary transformations ($p < .05$). Secondly, they produced significantly fewer generalized transformations as compared to the normal group ($p < .05$). This indicates that the language used by the autistic children is less complex than that of normal children with the same NLMA. The retarded group falls between the normal and the autistic, using fewer generalized transformations than elementary ones, and fewer generalized transformations than the normal group, but the difference in numbers does not reach significance, and can at most be interpreted as a trend.

To determine whether there was any relationship between NLMA scores and levels of grammatical complexity, as well as chronological age and levels of grammatical complexity, Pearson product-moment correlations (Bruning & Kintz, 1968) were conducted for each of the three groups separately, using the percentages of transformations determined for each subject individually. The only significant correlation that occurred in any of the groups when NLMA was used as a variable was between NLMA and the number of generalized transformations used by the autistic group ($r = +.95$, $p < .001$). When chronological age was used as a variable, the only significant correlation that occurred in any of the groups was between chronological age and the number of generalized transformations used by the retarded group ($r = +.87$, $p < .01$).

However, as mental age is a close function of chronological age, it was necessary to do partial correlations (Bruning & Kintz, 1968) on all sets of measures in all three groups. With the relational effects of chronological age partialled out, none of the correlations between NLMA and the linguistic measures of complexity in any of the groups was significant. With the relational effects of NLMA partialled out, however, the correlation between chronological age and the number of generalized transformations used becomes significant in the autistic group ($r_{ab.c} = +.64$, $p < .05$) and in the retarded group ($r_{ab.c} = +1$, $p < .001$). [The fact that no level of significance was achieved in the normal group is not surprising given the restricted range of chronological ages and nonlinguistic mental ages in that group]. The results of the Pearson product-moment correlation tests suggest that NLMA is a strong predictor of linguistic complexity in the autistic group. Only when partial correlations are used does the picture change. Consequently, these findings must be interpreted with caution.

Thus far, the underlying base grammars and the intermediate operations occurring between the underlying strings and the surface structures have been compared at least partially. In order to make some form of comparison of surface structures themselves, the accuracy with which they were produced was compared, utilizing the error rates which had been determined for each subject.

A one-way analysis of variance shows that there is a significant difference between the error rates of the groups

($F = 8$, $df = 3, 17$, $p < .005$). A Scheffé test shows that it is the autistic sample which has a significantly higher mean error rate than both the normal and the retarded samples ($p < .05$).

Pearson product-moment correlations were conducted on each group separately to determine whether there was a relationship between NLMA scores and syntactic accuracy, or between chronological age and syntactic accuracy. None of the correlations between any of the variables in any of the groups was significant. Partial correlations were done on all sets of measures in all three groups. The only significant correlation that appeared was when the relational effects of chronological age were partialled out in the autistic group. NLMA and error rate were inversely correlated. ($r_{ab.c} = -.67$, $p < .05$). In both cases with the effects of CA and the effects of NLMA partialled out in the normal group, there was a trend toward a significant inverse relationship between the remaining age variable and error rate ($r_{ab.c}$[CA partialled out] = $-.53$ and $r_{bc.a}$[NLMA partialled out] $= -.55$, $p < .1$). However, as the normal group made fewer errors than either of the other groups, and as they have a restricted range of age and performance scores, this finding must also be interpreted with caution.

Discussion

The results of this study permit several tentative generalizations to be made about the syntactic component of the language system of verbal autistic children. These, of course, must be verified in a larger population.

The outcome of the comparison of DSS scores suggests that the mastery of syntax in autistic children lags behind that of both normal and mentally retarded children who have attained the same level of nonlinguistic menal functioning. This is in keeping with Rutter's (1966) finding of variability in IQ subtest scores of autistic children. More so than in retarded children, the IQ's of the autistic subjects differed according to the intellectual functions examined, with autistic children displaying above average performance on some tasks and severely retarded performance on others. They generally did very well on block design and object assembly tasks and very poorly on verbal tasks and those demanding abstract thought and symbolic and sequential logic. As it was found that the pattern of scores was significantly related to global level of language attained, Rutter's finding supports the hypothesis that autism is primarily a linguistic disorder.

Also, the autistic group was found to be using less complex language in terms of transformation types, than normal children matched for NLMA. Nonetheless, the absolute forms of both the base grammars and the transformational components in our autistic group do not differ substantially from those of either the normal or the mentally retarded groups used in this study. It is interesting to note that Morehead and Ingram (1973) obtained similar findings in a comparison of aphasic and normal children. Moreover, the finding that children with higher NLMA tend to have more extensive rule

systems in their grammars is not unlike that of Lackner (1968) in a group of mentally retarded subjects. This suggests that the autistic children might be comparable in their syntactic performance to a group of younger normal or younger mentally retarded children. More longitudinal research of both normal children and children with language disabilities is crucial for a more substantive claim.

Another way in which the autistic children differ from our other two groups is that NLMA correlates with accuracy of syntactic productions in the autistic group alone. Although the structural properties of language in our autistic children, aside from being less developed than those of other children at similar levels of cognitive functioning have been found to be intact, it seems that it is in the functional use of language that a specific impairment in the autistic children manifests itself. Frith's (1970) study of pattern detection in autistic children complements our finding in that she concludes that autistic children appear to be able to construct "rules" similar to linguistic rules, but that they are deficient in their ability to apply these rules.

In conclusion, this study suggests that the grammatical system of autistic children is rule-governed but less complex than that of normal and mentally retarded children matched for NLMA. The impression of linguistic "bizarreness" so often reported in the clinical literature can be due in part to the

extreme delay and in part to the defective ability to use linguistic rules. This impairment, in turn, may be associated with underlying deficits not unique to language and may explain some of the atypical nonlinguistic behaviors observed in these children as well.

The extent to which semantic and socio-linguistic rule use is impaired and the possible contribution of deficits in these areas to the impression of "bizarreness" remain to be studied. The present study should also be complemented on the syntactic level by information about the performance of autistic children on specific tests of sentence comprehension and repetition. Also, the inclusion of a matched group of aphasic children, as well as younger normal children would help to more firmly establish the actual place of autistic children on the continuum of syntactic development.

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Footnotes

1) An analysis of the phonological abilities of autistic children as compared with mentally retarded and normal children is reported in the following studies:

1. Bartolucci, G., Pierce, S., Streiner, D., & Tolkin Eppel, P. Phonological investigation of verbal autistic, mentally retarded, and normal subjects. Journal of Autism and Childhood Schizophrenia, 1976, 6, 303-16.
2. Pierce, S. A comparison of phonological development in autistic, mentally retarded, and normal children. Unpublished Doctor's diss. Brown University.
3. Bartolucci, G., & Pierce, S. A preliminary comparison of phonological development in autistic, mentally retarded, and normal children. British Journal of Communication Disorders. (Forthcoming - October 1977)

2) An analysis of semantic aspects of the language of autistic children will appear in:

Pierce, S., & Bartolucci, G. An investigation of semantic cohesion in the story-telling of autistic children. In preparation.

Table 1

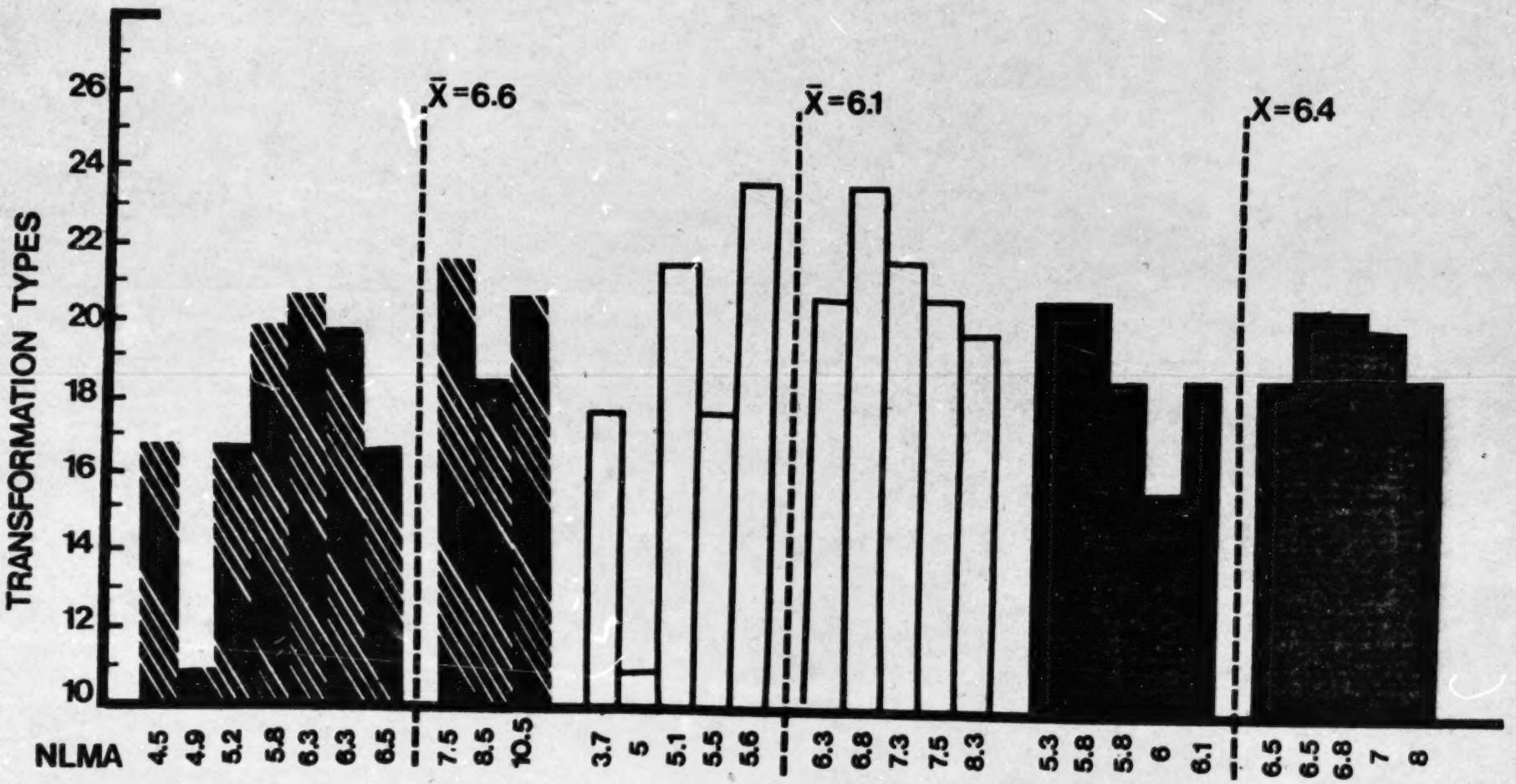
Summary Table of Group Characteristics

	Autistic	Retarded	Normal
N	10	10	10
Male/Female	10/0	8/2	6/4
Age	$\bar{X}$ = 10.85 s = 2.28	$\bar{X}$ = 10.52 s = 2.99	$\bar{X}$ = 6.27 s = .27
NLMA	$\bar{X}$ = 6.58 s = 1.87	$\bar{X}$ = 6.08 s = 1.44	$\bar{X}$ = 6.37 s = .77
IQ*	$\bar{X}$ = 61.60 s = 18.0	$\bar{X}$ = 59.5 s = 12.22	$\bar{X}$ = 101.8 s = 13.98
DSS	$\bar{X}$ = 6.7 s = 2.45	$\bar{X}$ = 8.55 s = 1.70	$\bar{X}$ = 10.26 s = 2.31

* $IQ = \frac{NLMA}{CA} \times 100$

Figure Caption

Figure 1. The number of transformation types according to nonlinguistic mental age.


AUTISTIC
RETARDED
NORMAL
TRANSFORMATION TYPES
26
24
22
20
18
16
14
12
10
X̄=6.6
X̄=6.1
X=6.4
NLMA
4.5 4.9 5.2 5.8 6.3 6.3 6.5 7.5 8.5 10.5
3.7 5 5.1 5.5 5.6 6.3 6.8 7.3 7.5 8.3
5.3 5.8 5.8 6 6.1 6.5 6.5 6.8 7 8